PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in the Driving Mechanism of Internal Combustion Engines.

I, PERCY GEORGE TACCHI, of 29, Nemoure Road, Acton, London, W. 3, British subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention comprises improvements in the driving mechanism of internal combustion engines, and is concerned with variable stroke engines of the kind in which the piston drive is transmitted to the engine or power shaft through a two-armed rocking lever, of which the fulcrum or axis of oscillation is capable of being shifted in a predetermined manner to alter the length of the lever arms and thus vary the oscillation of the lever and bring about the variation of stroke.

In engines of the kind in question, the rocking lever has already been mounted on a pivotally mounted bearer or carrier, in such a way that the latter could be moved longitudinally with respect to the lever to enable the fulcrum of the latter to be adjusted. In order to permit this movement of the bearer, however, some means has had to be provided for supporting or holding the lever against longitudinal displacement, otherwise the fulcrum would not have been properly adjusted and the lever might have taken up an unfavourable position for the running of the engine. In one previous arrangement, used in opposed cylinder engines, the rocking levers were supported by pivotal links, adapted to swing on pivots on the engine casing, and connected to the pivot pins at the connecting rod ends of the rocking levers. In another prior arrangement, in which, in addition, displacement of the lever was eliminated while the engine was running, a rack was disposed along one side of the rocking lever in engagement with a pinion fixed on the fulcrum shaft of the lever.

The principal object of the present invention is to provide improved means for preventing the rocking lever from being displaced longitudinally during adjustment of its fulcrum and while the engine is running.

According to the invention, in driving mechanism of internal combustion engines of the kind described, the rocking lever is supported or held against longitudinal movement on its bearer or carrier by a member or members adapted to oscillate or to be capable of articulating upon an axis with which the pivotal axis of the rocking lever is coincident during the whole or the greater part of the period of working of the engine. In this way, not only is the lever supported or held against longitudinal displacement during changing of the fulcrum and during the whole or practically the whole period of running, but support is applied at or from the pivotal axis, which is advantageous. In one arrangement, a worm in the rocking bearer or carrier acts as the member for supporting or holding the lever as stated; in another case, flexible cables or chains are used, while according to another construction, a pivotal link arrangement is employed. In the first two cases, the said axes are coincident at all times, so that the lever is not displaced longitudinally during any part of the running period. In the last-mentioned case, with pivotal link or links, the axes coincide only for high speed setting of the engine, and slight displacement of the lever takes place at lower speeds; nevertheless, as about 90 *per cent.* of the working is at high speed, it is clear that the said axes coincide during the major part of the working period.

[*Price* 1/-]

In order to enable the invention to be readily understood, reference is directed to the accompanying drawings, in which:—

Figure 1 is illustrative of an engine unit of the opposed piston type embodying improvements according to this invention, the cylinders and pistons being shown in vertical longitudinal section taken on the line I—I, Figure 2, and two different methods of transmitting the drive to the engine shaft being illustrated at the right and left hand halves respectively of the figure, that on the right being shown in elevation and that on the left partly in elevation and partly in section.

Figure 2 is a sectional view on the line II—II of Figure 1, with certain parts shown that are not seen in Figure 1, and other parts omitted that are shown in Figure 1.

Figure 3 is a cross section taken on the line III—III of Figure 1, but on an enlarged scale.

Figure 4 is a section on the line IV—IV, Figure 3, omitting the guides for the blocks *n* hereinafter described.

Figure 5 is a view looking in the direction of the arrows approximately from the plane of the section line V—V of Figure 1.

Figure 6 is a sectional elevation of a modification.

Figure 7 is a section on the line VII—VII of Figure 6.

Figure 8 is a plan view of the block n^1 hereinafter described, and

Figure 9 is a detail view showing the block n^1 in vertical section and illustrating the manner in which the rocking lever oscillates in the block.

The engine unit illustrated by Figure 1 comprises opposed pistons *a* a^1 working in cylinders *b* b^1 which are co-axial and superposed above and at right angles to the engine shaft *c*. Preferably, there is a common compression and combustion space *d* between the pistons, and the working may be according to the two-stroke or four-stroke principle. The latter is illustrated in Figures 1 and 2 and a suitable arrangement of admission and exhaust valves *e*, *f*, respectively, is seen in these figures. The inlet valve may be of the automatic type as shown while the exhaust valve may be operated from a gear-wheel *g* on the engine shaft through suitable reduction gear and a cam shaft in any apparent or well-known manner, which needs no illustration. The drive from the pistons is transmitted to the power or crank shaft *c* through the medium of piston rods *h*, rocking levers *j* and connecting rods *k* as will be hereinafter more particularly described.

As stated above, two different methods of transmitting the drive from the pistons to the engine shaft are illustrated respectively at the left and right hand sides of Figure 1, and description will first be given of the drive shown at the right-hand side of the figure. The two methods are illustrated in the one engine in Figure 1 purely for the sake of convenience. In actual practice the same method of driving would generally be adopted for all cylinders of a multi-cylinder or opposed piston engine.

In the arrangement shown at the right-hand side of Figure 1, the lever *j* is adjustably supported in a rocking carrier *l* (see also Figures 3 and 4) and this carrier is adapted to oscillate in a bearing sleeve *m* fixed in blocks *n* which are adapted to slide along pairs of guides *o* on brackets *p* formed or mounted on the engine casting *q*. The blocks *n* are of the nature of mangle-roller bearing blocks and they are held in the guides *o* by the nuts *r* on the ends of the bearing sleeve *m*. The rocking carrier *l* is conveniently of cylindrical form as shown and, in effect, it forms the trunnions of the rocking lever *j*. The blocks *n* are adapted to be moved along the guides *o* by screwed spindles *t* which engage internally screw-threaded parts at the upper and lower ends of the blocks as seen in Figure 4. The screwed spindles *t* are adapted to be rotated both in the same direction to give uniform and similar travel of the blocks *n* in their guides, and this rotation may be imparted to the spindles in any convenient manner for example, through worm and worm wheels or other gear driven by the engine as will be readily understood.

The object in adjusting the blocks *n* as described is to permit of shifting the axis or centre of oscillation of the rocking lever *j*, so that the length of the respective arms of the lever and thus their arc or degree of oscillation shall be varied. It will be apparent that in effecting this, the rocking carrier *l* must move longitudinally of the rocking lever, and therefore it is important that the latter shall be supported or held against longitudinal displacement during that movement. In fact, the rocking lever should maintain substantially the same disposition vertically, otherwise it might drop or get into a position unfavourable for transmitting the drive to the crank shaft *c*. In order to provide for this, a worm and rack connection is provided between the screwed spindles *t* and the lever *j* and such a connection will now

be described with particular reference to Figures 3 and 4. From these figures it will be seen that the screwed spindles t pass through the rocking carrier l, on opposite sides of the lever j, and that a worm u is arranged on each spindle in mesh with a suitable rack v on either side face of the rocking lever. When the screwed spindles are turned to shift the axis of oscillation of the rocking lever, the worms u also turn and work along the racks v both in the same direction axially, thus allowing the shifting to take place and at the same time supporting and preserving the vertical disposition of the rocking lever so that, generally speaking, the latter is not moved vertically with the adjustment of the rocking carrier l. The direction and pitch of the thread of the screwed spindles t and worms u and the thread direction or formation of the racks v should be such, as it were, that the worms creep along the racks as the spindles t are turned. It is necessary to allow for the rocking lever j oscillating in all positions of adjustment of the screwed spindles t and worms u and therefore the connection between the worms and the screwed spindles must be of the nature of a universal joint. This is obtained by providing on the screwed spindles t a spherically-shaped member or ball w which has co-axial pairs of pins or projections x arranged on axes at right angles to one another as will be understood from Figure 3. Each ball w is feathered to its spindle t by a feather or key w^1 and groove w^2 so as to be capable of sliding along the spindle while being turned by the latter, and the projections x take into curved slots y in the interior of the worms u which are spherically bored and formed in halves to allow them to enclose the balls w as will be understood from Figure 4. The projections and slots x y ensure that the worms u will turn with the spindles t so as to creep along the racks v as aforesaid, while at the same time they permit of universal movement between the spindle t and worms u. The worms u and rocking carrier l are hollowed out or slotted as shown at z to allow of the rocking movement thereof with respect to the screwed spindles t and the sleeve m is also slotted as shown at 1 to permit the rocking of the lever j. The worms u are inserted into a rectangular bore l^1 of the rocking carrier from either end thereof and the feather ways or grooves w^2 extend to one or both ends of the spindles t to enable the latter to be passed through the worms u and balls w and over the key w^1 in the assemblage of the rocking lever supports.

It will now be understood that by adjustment of the screw spindles t and the consequent movement of the blocks n along the guides o, the axis of oscillation of the rocking lever can be shifted and at the same time, owing to the corresponding movement of the rocking carrier l along the rocking lever j, the length of the lever's arms and the arc or degree of oscillation thereof can be varied. By way of example, three different positions O^1 O^2 O^3 of the said axis are diagrammatically represented at the right hand side of Figure 1, and the corresponding arcs of movement of the lever arms are lettered A^1 A^2 A^3. The upper set of arcs indicate, by their different lengths, that the stroke of the piston a is varied with the movement of the axis of oscillation of the lever j. The travel of the lower end of the rocking lever j remains substantially constant which is necessary because its degree of movement is dictated by the throw of the cranks of the engine shaft. The different lengths of the piston stroke corresponding to the arcs A^1, A^2, A^3 are shown by the reference letters S^1—S^1, S^2—S^2 and S^3—S^3. In practice, the inclination of the guides o would preferably be so chosen that as the piston stroke is progressively increased, the combustion space d also progressively increases in volume in known manner with the result that the compression for all lengths of stroke may be substantially constant. The lengthening of the stroke corresponds to a decrease of the engine speed because the piston has to travel farther for each revolution of the crank shaft, and a shortening of the stroke gives an opposite effect. Preferably the displacement rate of the piston is made approximately constant for all speeds and so that the horse power may also be constant. By varying the inclination of the guides o, however, it is possible to give the compression ratio a progressive character instead of a constant character as above described.

According to the arrangement shown at the left-hand side of Figure 1, the guides o aforesaid are dispensed with and the shifting of the axis of oscillation of the rocking lever j is effected by mounting it in a rocking carrier 2 which is pivotally supported on the forked end of a control arm 3 whose outer end or head is capable of being moved up and down by pivotally adjusting such arm, in any convenient manner, about the axis of the crank shaft c as at 3^a (see Figure 2). Strictly speaking, the movement of the axis of oscillation of the rocking lever j should be along a straight line as at the right-hand side of Figure 1, but owing

to the appreciable length of the control arm 3, the movement of this axis at the left-hand side of the figure, approaches near enough to a straight line as to be satisfactory for practical purposes. The rocking lever *j* in this arrangement is supported by a chain 4 depending from a bracket 5 secured to the engine casting *q*, the chain being connected at its lower end to a stud or projection 6 on the rocking lever as will be seen from Figure 5 and being adapted to articulate at the pivotal axis of the lever 7. A duplicate chain 7 is provided on the opposite side of the lever *j* to the first-mentioned chain, to prevent movement of the rocking lever in the upward direction this chain being connected between another bracket 8 on the engine casting and a stud or projection 9 on the rocking lever. The carrier 2 is of such construction that it is capable of sliding along the rocking lever *j* and the latter is of plain rectangular section at the central portion 10 of its length to allow of this movement. As shown the carrier 2 comprises a central sleeve-like part movable along the lever portion 10 and trunnions 11 projecting from each side of the sleeve-like part as will be seen in Figure 5. These trunnions 11 are supported in the forked head of the control arm 3, which has bearing sleeves 3^b, and they and such head and sleeves are suitably slotted as at 12 for the passage of the chains 4 and 7 and to allow of the necessary movement of such head and trunnions with respect to the chains. This is shown in section at the left-hand side of Figure 1, in which the front fork member of the head of the arm 3 is detached and removed for the sake of clearness. If desired, flexible cables may be substituted for the chains 4 and 7, and in this event, instead of the cables passing through the trunnions 11 diametrically as shown in Figure 1, they may pass from their brackets 5, 8 into and through axial holes in the trunnions and be diverted downwardly or upwardly as the case may be, just within the sleeve part of the carrier 2, to studs such as 6 and 9, the lever *j* or the carrier being grooved to accommodate the cables.

It is necessary, in this construction, to lock the sleeve 2 with respect to the rocking lever *j* once the adjustment of the axis of oscillation has been made. This may be done in any suitable manner, and a convenient arrangement is diagrammatically shown comprising two eccentric cams 13 pivotally mounted in lugs 21 on the sleeve part of the rocking carrier 2 and projecting through slots in the sleeve so that they may jam against the rocking level *j* under the action of a spring 14. The pivots of the cams are provided with arms 15, 16 respectively, connected by a link 17 and the pivot of the upper cam also has an arm 18 connected with a release rod 19 adapted to be moved, for example, by a handle 20 pivotally mounted on the control rod 3. In the case of a motor car engine the rod 19 could be operated from the driver's seat as will be readily understood. It will be observed that the lower one of the cams 13 could be dispensed with if desired as it only constitutes a duplication of the upper cam. The use of two cams, however, is preferable as this gives better support for the rocking carrier 2. The operation of the locking cams is simple. They can be released from the locking position to allow adjustment of the axis of oscillation of the rocking lever, by movement of the handle 20 in the direction of the arrow and as soon as the handle 20 is released the spring 14 brings the cams 13 to locking position.

In the case of the construction shown at the left-hand side of Figure 1, progressive alteration of the compression ratio can be obtained by arranging for the lower end of the control arm 3 to be pivotally supported in an adjustable manner instead of upon the crank shaft *f* as shown. For example, it could be pivotally mounted on a horizontally movable slide as will be readily understood. In this way, adjustment of the pivot brings about an alteration of the path of adjustment of the axis of oscillation of the rocking lever *j* which is equivalent to a variation of the inclination of the guides *o* in Figure 1.

The arrangement at the left-hand side of Figure 1 is somewhat simpler than that shown at the right-hand side of that figure, because the universal joint movement is eliminated, the flexibility of the cables or chains 4 and 7 allowing of the necessary pivotal movement of the rocking lever in all positions of adjustment of its axis of oscillation.

The rocking levers and their appurtenant mechanisms are suitably enclosed by covers or casing parts 22 bolted on to the ends of the engine casting as seen in Figure 1, and covers 23 may be provided front and rear of the engine as shown in Figure 2. The crank shaft is suitably mounted in bearing blocks 24 on the base 25 of the engine and the cylinders b b^1 may be cast integrally with the casing *q* or cast separately and mounted thereon as shown. The engine casting *q* is bolted down to the base 25 by its legs q^1 and the connecting rods *k* pass from the rocking levers centrally between these legs and are then conveniently bent to their

cranks k^1 on the engine shaft c. Owing to the pistons being in axial alignment, as hereinbefore stated, the cylinders can be cast in one piece as shown and readily bored to true internal diameter. It is not essential, however, for the pistons to be in axial alignment and as will be readily understood, an engine may comprise any number of pairs of cylinders b b^1 arranged side by side with their pistons driving a common engine shaft. It is also possible to apply the drive to the engine shaft by means of eccentrics in known manner instead of by cranks.

If desired, the rocking lever may be supported by a link or links, as an alternative to the screw gear or chain or cable illustrated in Figure 1. For example, and as shown in Figures 6 and 7, it may be supported by two links 26 which depend pivotally from fixed supports or brackets 27 on the engine frame 28 and are pivotally connected to the coupling pin 29 at the lower end of the rocking lever j. The latter is adapted to rock in a block n^1 mounted so as to be capable of sliding in two pairs of guides o^1, o^2. One guide o^1 of each pair may be formed on the engine frame or casting as shown and the other, o^2, may be detachably secured in position upon distance pieces or blocks 30 by bolts 31. The formation of the block n^1 will be readily understood from Figures 8 and 9. The lever j has a sliding fit in the block and is adapted to rock on the surfaces n^2. As an alternative, blocks like those marked n in Figure 1 may be used with a carrier like l in that figure excepting that there would be no definite connection between the lever and carrier such as is provided by the worm and rack u, v. The block n^1 may be moved along the guides o^1, o^2 in any suitable manner. For example, and as shown, the block may be fitted with projecting pins 32 adapted to be engaged by bell-crank levers 33 pivoted on the engine frame at 34 and adapted to be turned on their pivot by movement of a block 35 in guides 36 on the engine framing under the action of a feed screw 37. The block 35 has pins or projections 38 at each side for engaging the respective bell-crank levers, and the latter at each end are slotted as shown to engage these pins and the pins 32. The feed screw 37 may be formed with a squared end 39 for reception of a handle or it may be operated in any other suitable manner. The piston a, as before, oscillates the rocking lever j through a connecting rod h and the rocking lever turns the crank-shaft c through the connecting rod k. The cylinder b is only shown diagrammatically, the inlet and exhaust valves and connections being omitted.

In operation, it will be observed that the lower end of the rocking lever j is constrained to move in a circular path which is determined by the links 26. Therefore, when the axis of the rocking lever is out of coincidence with the axis of the links, which have a common axis, there will be a slight reciprocating movement of the rocking lever in the block n^1 as the lever oscillates. In practice, however, this will not matter, because approximately 90% of the running of the engine is done at highest speed and the design is such that at this speed, the axes of the rocking lever j and links 26 coincide. The rocking lever then will not reciprocate in its block n^1.

The movement of the axes of oscillation of the rocking levers, may be automatically governed by the engine itself, if desired, as by governor control. Moreover, engines embodying the present improvements may operate according to the two or four stroke principle and they can be constructed to have a constant piston and gas displacement rate while running within a fairly wide range of speed, say of 500 to 1500 revolutions per minute.

Also they may be of single or multiple piston and cylinder type. Preferably, an engine unit is employed having opposed pistons with explosion taking place between them, as in Figure 1 for example, but any multiplication of such units may be used with either eccentric or crank drive on to the engine shaft.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In driving mechanism of internal combustion engines of the kind described, supporting or retaining the rocking lever against longitudinal movement on its bearer or carrier, by a member or members adapted to oscillate or to be capable of articulating upon an axis with which the pivotal axis of the rocking lever is coincident during the whole or greater part of the period of working of the engine, substantially as described.

2. In driving mechanism of internal combustion engines, in accordance with Claim 1, supporting or holding the rocking lever against longitudinal displacement by a worm or worms mounted in the rocking bearer or carrier of the lever and engaging a rack or racks on such lever, substantially as described.

3. In driving mechanism of internal combustion engines, in accordance with

Claim 1, supporting or holding the rocking lever against longitudinal displacement by one or more flexible chains or cables adapted to articulate at the pivotal axis of the lever, substantially as described.

4. In driving mechanism of internal combustion engines, in accordance with Claim 1, supporting or retaining the rocking lever against longitudinal movement by a pivoted link or links mounted to swing on an axis with which the pivotal axis of the lever is coincident during the high-speed setting of the driving mechanism, substantially as described.

5. In driving mechanism of internal combustion engines, as claimed in Claim 2, mounting the rocking bearer or carrier in blocks adapted to slide in guides under the direct action of screws, and arranging for the screws to operate the worms in the carriers through a universal connection, substantially as described.

6. Driving mechanism of internal combustion engines, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

7. An opposed piston engine comprising aligned cylinders superimposed above and at right angles to the engine shaft substantially as described with reference to Figures 1 and 2 and further comprising driving mechanism substantially as hereinbefore described with reference to the right-hand part of Figure 1 and Figures 2, 3 and 4 or with reference to the left-hand part of Figure 1 and Figures 2 and 5 of the accompanying drawings.

Dated this 16th day of November, 1923.

JENSEN & SON,
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Chartered Patent Agents.

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Fig.1.

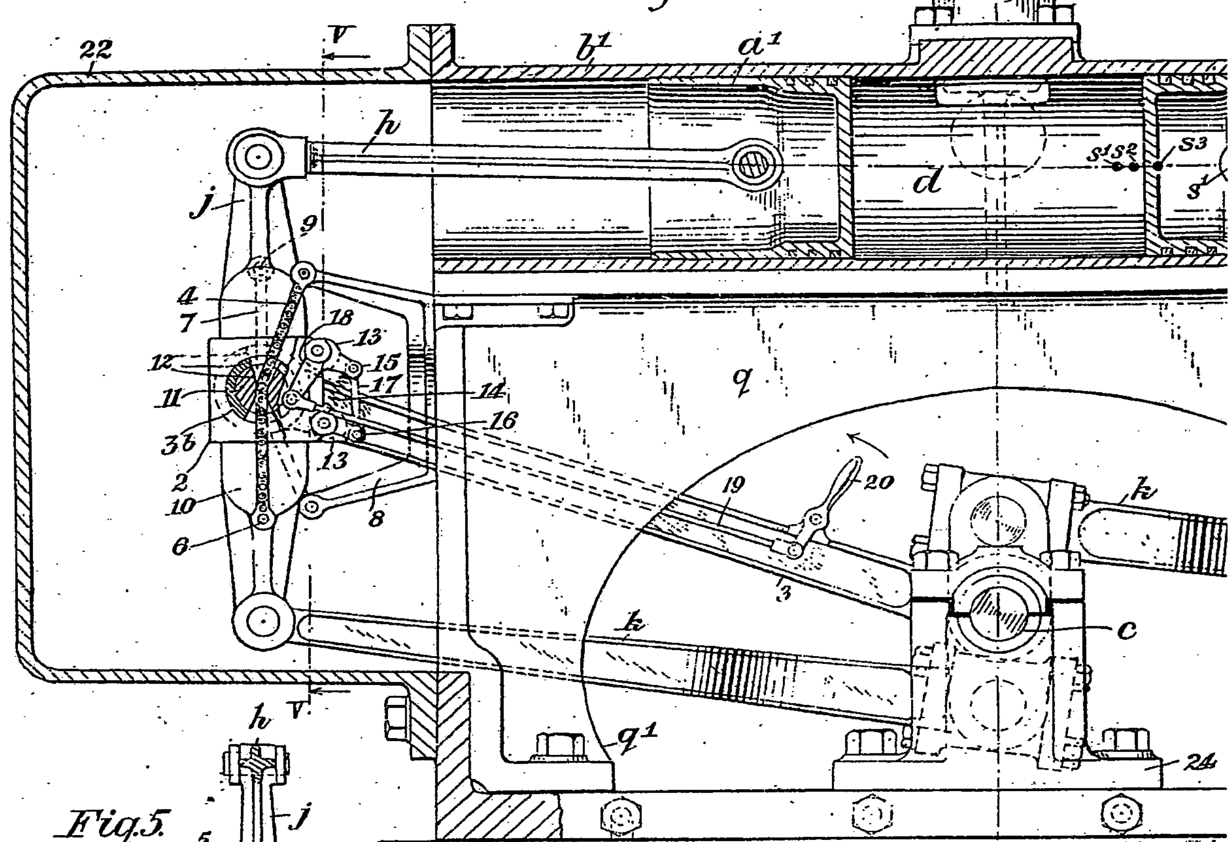


Fig.5.

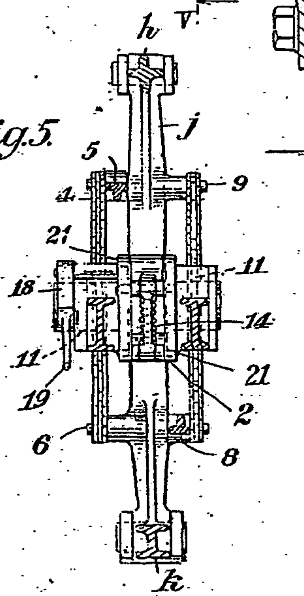
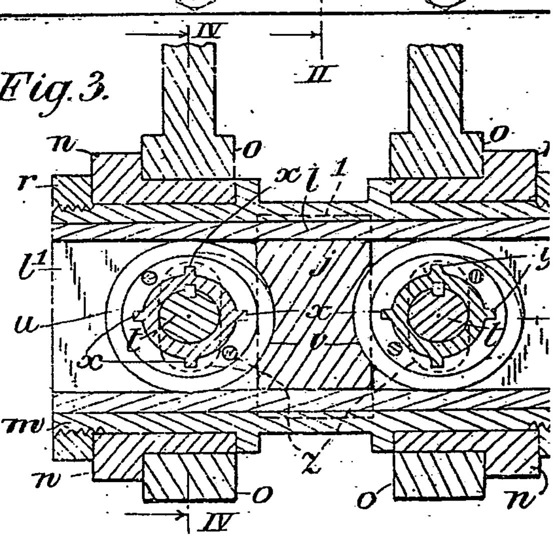


Fig.3.



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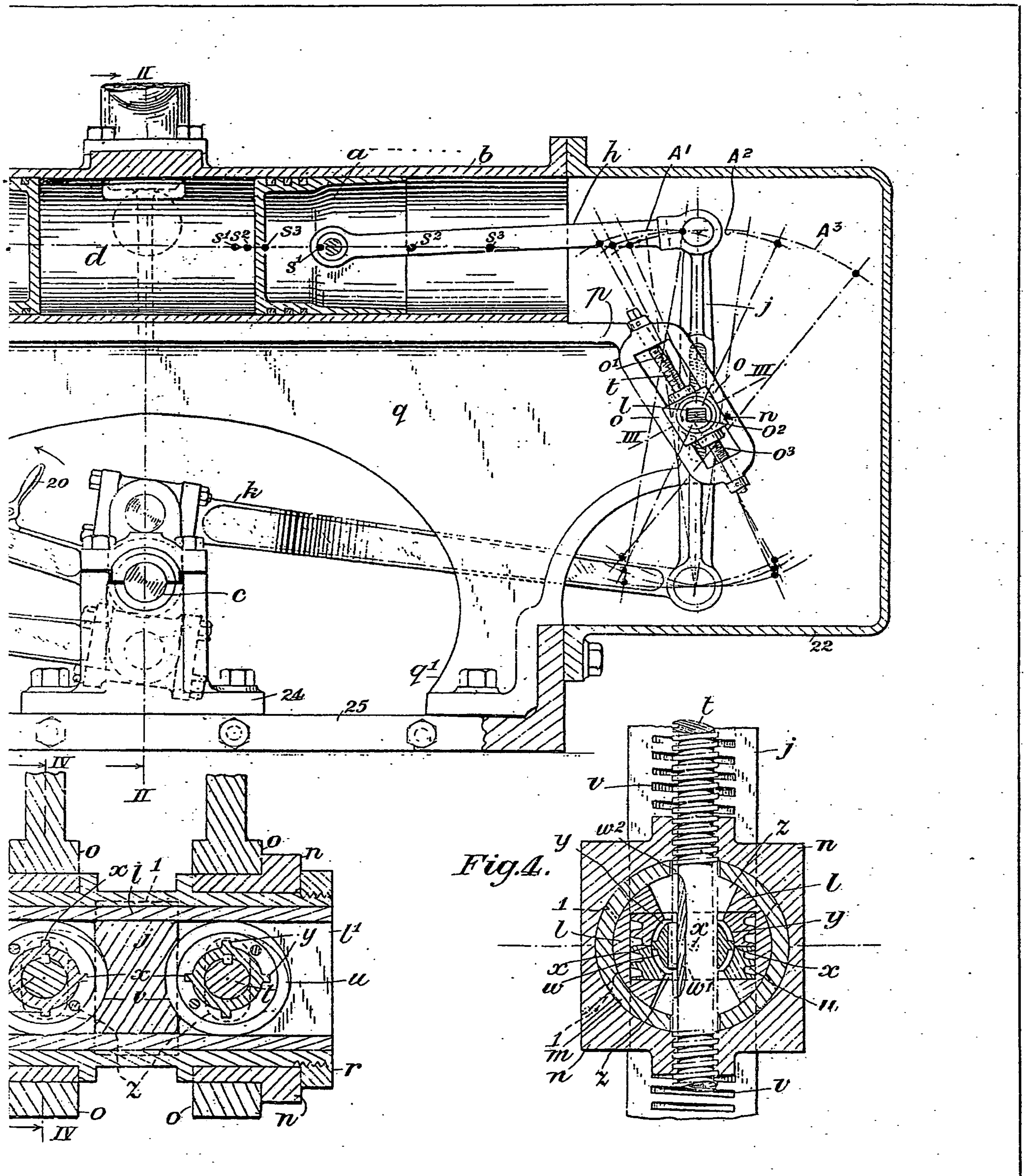
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Fig.4.

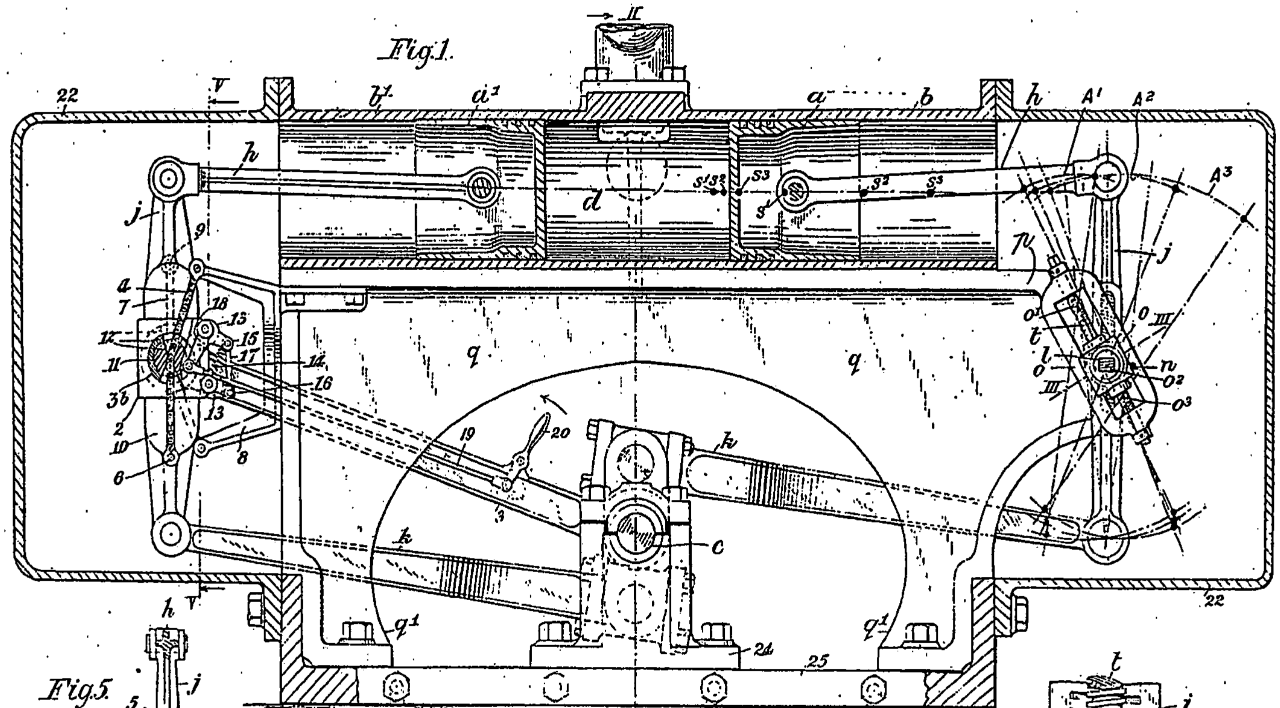

Fig.1.

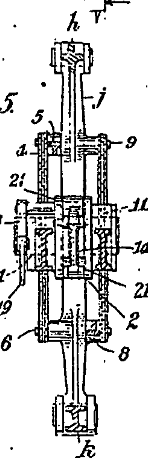

Fig.5.

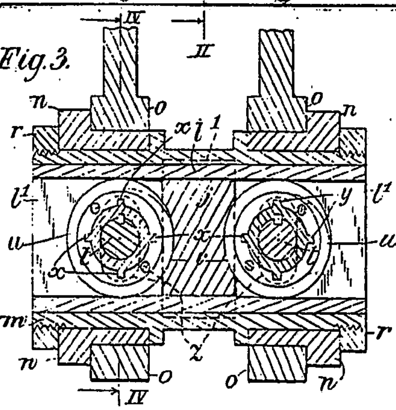

Fig.3.

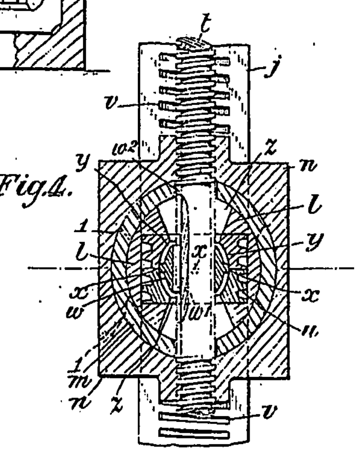

Fig.4.

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Fig. 2.

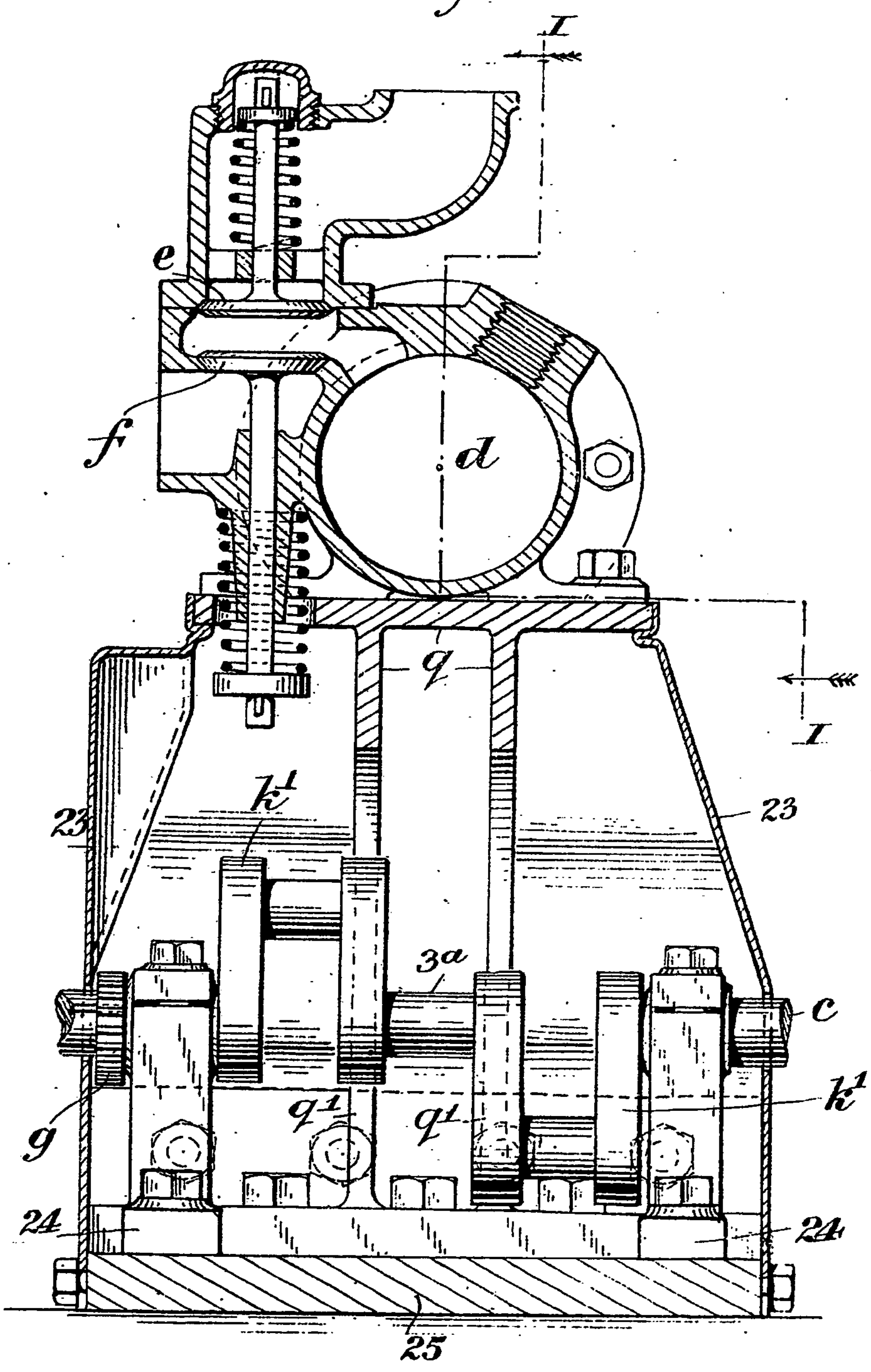

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Fig. 6.

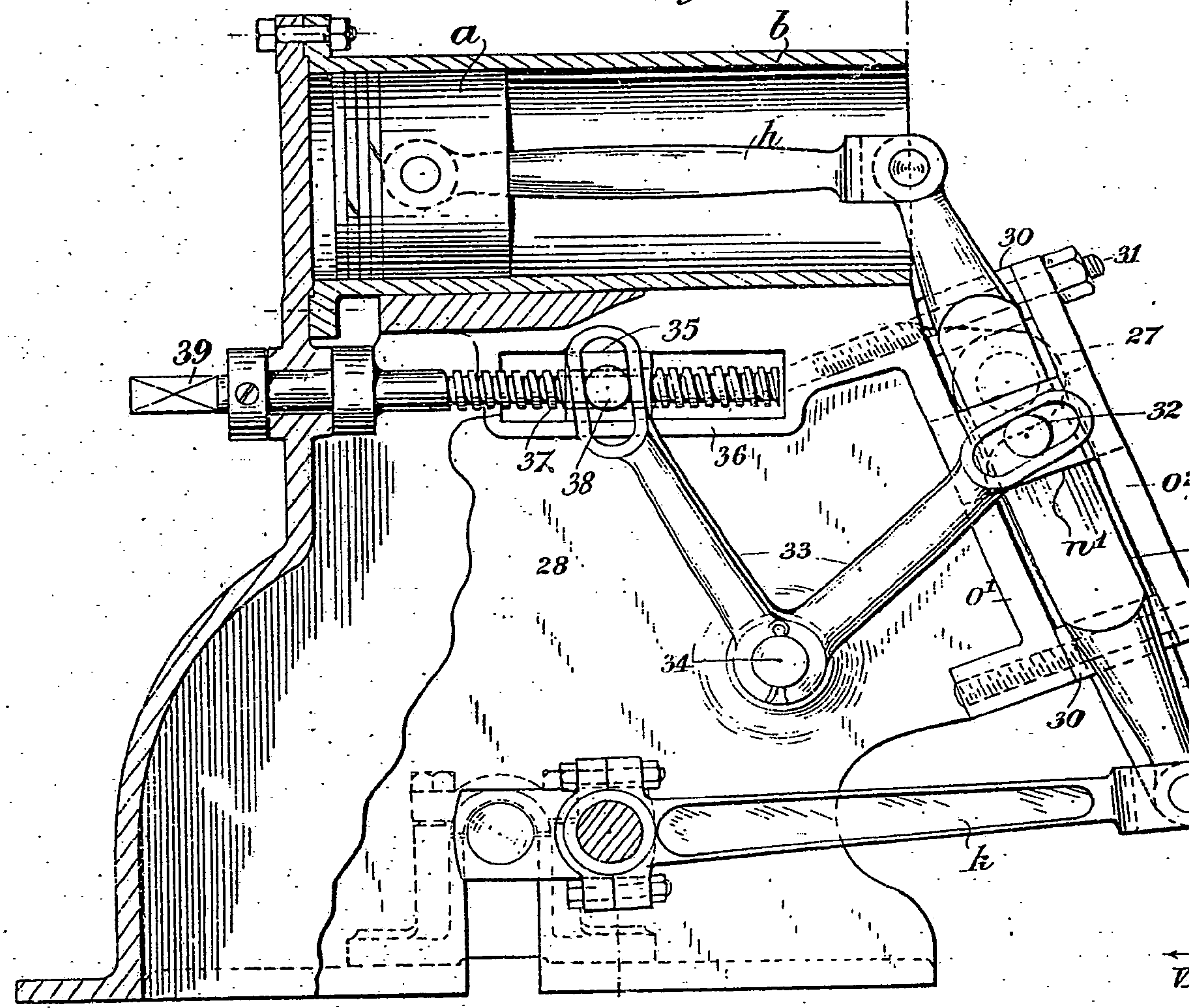
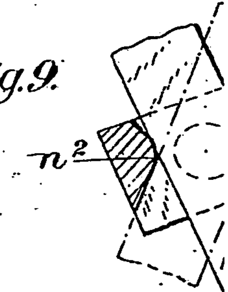


Fig. 9.



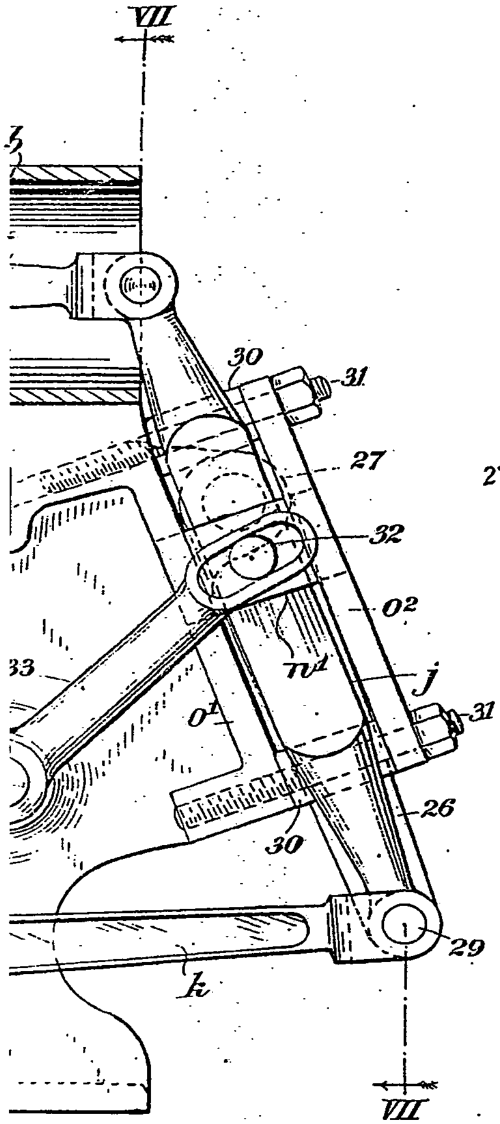


Fig. 7.

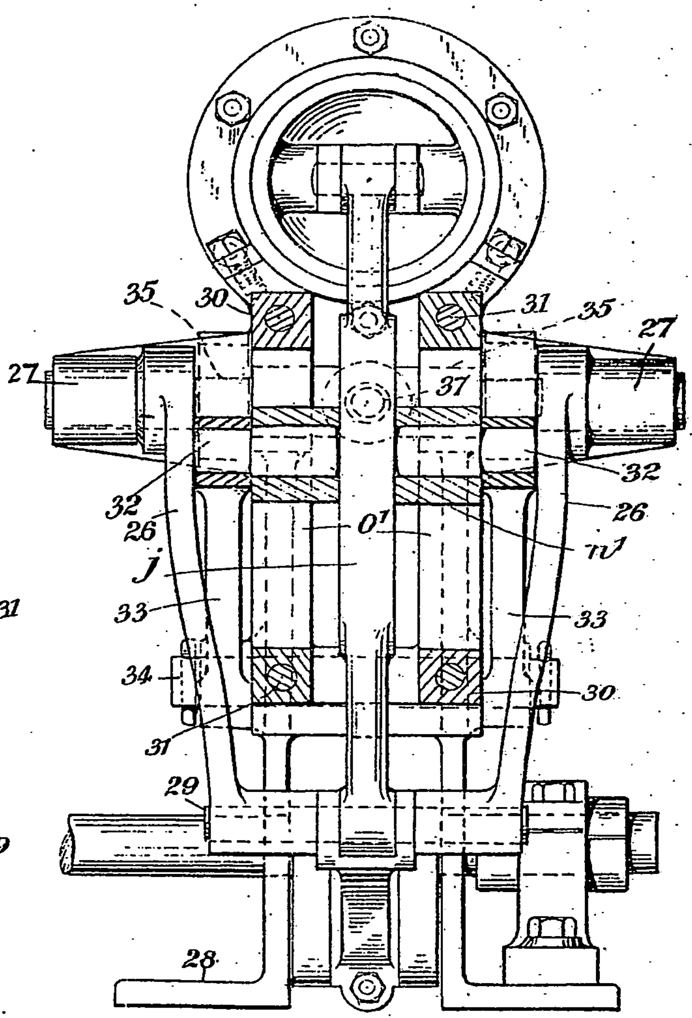


Fig. 9.

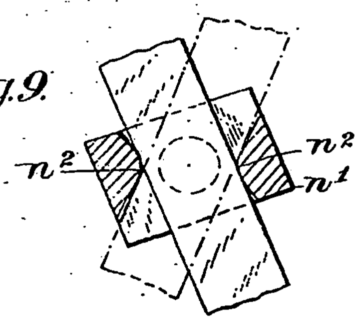
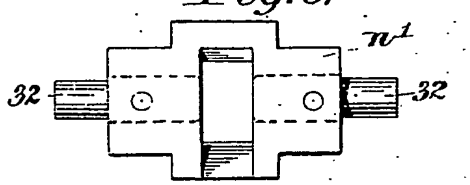


Fig. 8.



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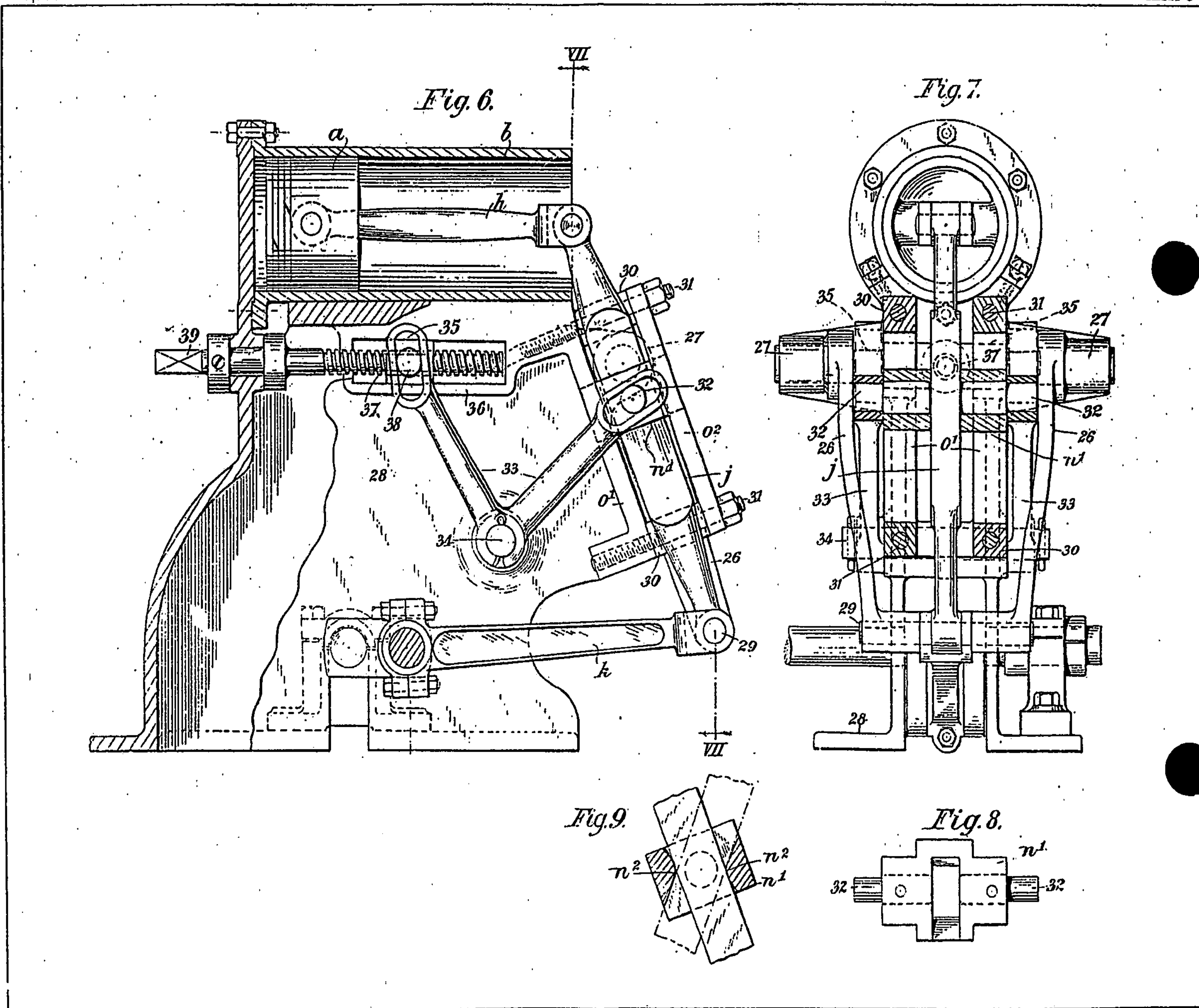

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